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CALCOFI OCEANOGRAPHIC DATA RETRIEVAL PROGRAM RUNCCOFI

By

L.E. Eber

ADMINISTRATIVE REPORT LJ-92-27

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INTRODUCTION

Repeated oceanographic observations have been made over a grid of stations in the California Current since 1949. The grid was designed for a systematic sampling program to determine the major spawning areas of the Pacific Sardine off the west coasts of the United States and Baja California, Mexico. With the demise of the sardine, emphasis in the program was redirected toward the Northern Anchovy.

The oceanographic (physical and chemical) data from CalCOFI surveys have been compiled by Scripps Institution of Oceanography (SIO) and published in a series of data reports. The parameters include temperature, salinity and oxygen tabulated at observed and at standard depths, and derived values of sigma-t, thermocline anomaly and geopotential anomaly at standard depths. Observations of phosphorus, nitrite, nitrate and silicon are also included.

The SWFSC computer file of CalCOFI data started with copies of tapes for the period 1950-1968, prepared by SIO for archiving at the National Oceanographic Data Center. Subsequent updates have been made to the SWFSC database through loans of cruise data on punched cards and, more recently, magnetic tapes from SIO. The data obtained from these cards and tapes did not contain interpolated (standard depths) or computed (density) data. Computed and interpolated values were added to the SWFSC data files using algorithms from SIO programs. In the early 1980's, SIO replaced the density parameter Sigma-t with Sigma-theta in the physical and chemical data reports. SWFSC has continued to use Sigma-t.

The first major application of the oceanographic database at SWFSC was the preparation of time series of oceanographic parameters at 23 stations in the CalCOFI pattern. The selected parameters were temperature, salinity, oxygen and sigma-t. Nutrients were not included because they were not represented in the database with sufficient continuity. The time series were depicted as contoured plots of each of the parameters, against coordinates of depth and time. This work was published as CalCOFI Atlas No. 25. The plots were created with a mapping program (EDMAP) which required that data files conform to particular format specifications. Consequently, a binary file was created in the prescribed format, that contained data for six parameters at fourteen standard depths (between 0 and 500 meters) for the period 1950-1966. This file has been maintained and updated and now extends through 1991. It is identified by the name OCNDATA, which is recorded as the first field in every header record in the file. Header records contain identification fields for CalCOFI stations and precede the data records obtained from each hydrographic cast.

Since 1985, the portion of the CalCOFI station pattern occupied during cruises has been delimited by line 76.7 in the north and line 93.3 in the south. Cruises have been conducted four times each year. During this time, the archive format used by SIO for the physical and chemical data has stabilized and continuity of nutrient data has been good. Consequently, since 1985, an ASCII file has been maintained which includes data for all observed parameters, including nutrients, for all depths processed by SIO. This file also extends through 1991. It is identified by the name PCDATA, which appears in the first field in the header record of every station in the file.

THE RUNCCOFI ENVIRONMENT

RUNCCOFI is a menu driven, interactive program written to facilitate access to the SWFSC database of CalCOFI oceanographic data. Access is provided through a collection of programs which can be executed from RUNCCOFI. They are grouped by function and listed in four menus. The first menu (Figure 1) includes programs for retrieval and manipulation of oceanographic data in the OCNDATA format. These files contain data for six parameters at standard depths to 500 meters. The parameters are temperature, salinity, oxygen, sigma-t, percent oxygen saturation and dynamic height anomaly.

Figure 1.

MENU 1. Data retrieval and file manipulation

Move cursor to the desired line and press <ENTER>.

PRNT_OCN..Display data from OCNDATA files on screen. Reformat from
binary to ASCII or vice versa.

MAKE_SUB..Create binary subfiles from OCNDATA files.

ADD_STN..Combine files in OCNDATA format.

SORT_OCN..Sort OCNDATA files by line and station.

PART_OCN..Partition OCNDATA files into year or cruise files.

Execute a DOS command.

Press <ESC> to exit this menu.

The second menu (Figure 2) includes programs for updating the SWFSC database as new data becomes available. This includes reformatting from the SIO to SWFSC format, interpolating to standard depths and computing density parameters.

THE BULKY BOTTLE

THE BULKY BOTTLE is a new kind of bottle which is designed to hold a large amount of liquid. It is made of a special material which is very strong and does not break easily. The bottle is very tall and thin, and it has a long neck. It is very easy to use, and it is very cheap. It is a very good bottle for many different purposes. It is a very useful bottle, and it is a very good bottle for many different purposes.

Figure 1

Figure 1. The bottle and its dimensions.

More space is the better the the bottle.

THE BULKY BOTTLE is a new kind of bottle which is designed to hold a large amount of liquid. It is made of a special material which is very strong and does not break easily. The bottle is very tall and thin, and it has a long neck. It is very easy to use, and it is very cheap. It is a very good bottle for many different purposes. It is a very useful bottle, and it is a very good bottle for many different purposes.

MAKE THE BULKY BOTTLE FROM THE BULKY BOTTLE.

ADD THE BULKY BOTTLE TO THE BULKY BOTTLE.

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THE BULKY BOTTLE IS A BULKY BOTTLE.

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Figure 2

MENU 2. File update and maintainance

Move cursor to the desired line and press <ENTER>.

UNBLKDPG..Unblocks files in DPG (SIO) tape format.

DPG_PCD..Convert DPG (SIO) format to PCDATA format.

EDIT_PCD..Add density parameters, perform range checking.

UPDATOCN..Convert PCDATA files to OCNDATA format.

SORT_OCN..Sort OCNDATA files by line and station.

PROD_HDR..Extract PR header records from PCD files.

MAKE_PCD..Data entry program to create PCDATA files.

Press <ESC> to exit this menu.

The third menu (Figure 3) contains utility and special purpose programs. The latter modify OCNDATA files for input to the mapping program EDMAP.



Figure 3

MENU 3. Utility programs and subroutines

Move cursor to the desired line and press <ENTER>.

GRID_CON..Converts line, station codes to Lat and Lon.

MARK_OCN..Marks and inserts data records into OCNDATA files.

NTRP_OCN..Creates OCNDATA file of interpolated values.

PCD_INDXX..Finds and lists header records on PCDATA files.

INVT_DYN..Converts DYN HGT reference level to 500 meters.

Press <ESC> to exit this menu.

The fourth menu (Figure 4) contains programs for computing and using harmonic coefficients to obtain estimates of the long term means of oceanographic parameters at CalCOFI stations with adequate histories of observations. A main menu is provided from which the other menus can be activated.

Figure 4

MENU 4. Harmonic coefficients

Move cursor to the desired line and press <ENTER>.

RTRV_HMC..Compute means, anomalies or standard deviations.

PRNT_HMC..Print harmonic coefficients for selected stations.

HMC_INDXX..Index the harmonic coefficients file.

FIT_HMC..Compute harmonic coefficients from OCNDATA files.

Press <ESC> to exit this menu.

RUNCCOFI and its affiliated program files must reside in the default directory at execution time. The default directory can be on the hard disk, or on a fast peripheral drive, such as a Bernoulli drive. A floppy drive is not recommended. The OCNDATA and PCDATA data files



that make up the SWFSC database are stored primarily in separate subdirectories on a 90mb Bernoulli cartridge. Secondary copies are stored on 5.25in 1.2mb floppy disks. Database files used for input to RUNCCOFI programs can be accessed from any available subdirectory provided the complete path is included when submitting file names. Output files can be similarly directed to any desired subdirectory. Descriptions of the programs in each menu are given in the following sections.



Menu 1. RETRIEVAL OF CALCOFI DATA

PRNT_OCN

This program is used to display files in the OCNDATA format, to copy files from binary to ASCII and vice versa, and to block files for copying to magnetic tape. There are three display options: PRINT, HEADERS and INDEX. With each, the data displayed can be echoed to the printer if desired. PRINT displays the entire contents of a file. HEADERS displays only the header records containing the station code, latitude, longitude, cruise code, date, etc. INDEX displays only the station and cruise codes from the header records. The other options create new files with modified formats. DISKA creates a ASCII file from a binary file. DISKB creates a binary file from an ASCII file. TAPE creates a blocked ASCII file (with blocking factor = 20) from an ASCII file created by DISKA.

MAKE_SUB

This program creates a subfile from an OCNDATA file in binary format. It provides three options for selecting data from the source file: cruises, stations and standard depths. After choosing an option, the user must submit a list of codes for that option. The select list can be entered from the keyboard or from a disk file. In either case, it must be preceeded by the list count. The select list can be used to exclude, rather than accept, data for the subfile by choosing the delete option. The select list can be submitted as a range by choosing the range option. In that case, the list would contain just two select codes, the first and the last. For example, by choosing the range option the list entries

2 77049 93120

would select all of the station codes between 77049 and 93120.

The six digit line_station code is required for selecting stations (leading zeros can be omitted). The four digit cruise codes are required for selecting cruises (9101, 9103, etc.). Standard depths are recorded in meters and must be selected from the following list:

0 10 20 30 50 75 100 125 150 200 250 300 400 500.

ADD_STN

This program combines two OCNDATA files in binary format into a new OCNDATA file in binary format. The source files can each contain data from more than one cruise. The data will be merged while being copied to maintain the chronological order of cruise codes and increasing order of station codes within cruises.

The first part of the paper discusses the importance of the study of the history of the United States. It is argued that a knowledge of the past is essential for a full understanding of the present. The author then proceeds to discuss the various factors that have shaped the development of the United States, including the role of the government, the influence of the economy, and the impact of the culture.

The second part of the paper discusses the role of the government in the development of the United States. It is argued that the government has played a crucial role in shaping the country's history, from the founding of the nation to the present day. The author then discusses the various ways in which the government has influenced the economy, the culture, and the society.

The third part of the paper discusses the influence of the economy on the development of the United States. It is argued that the economy has been a major factor in shaping the country's history, from the early years of settlement to the present day. The author then discusses the various ways in which the economy has influenced the government, the culture, and the society.

The fourth part of the paper discusses the impact of the culture on the development of the United States. It is argued that the culture has been a major factor in shaping the country's history, from the early years of settlement to the present day. The author then discusses the various ways in which the culture has influenced the government, the economy, and the society.

The fifth part of the paper discusses the future of the United States. It is argued that the country's future will be shaped by the choices that it makes in the years ahead. The author then discusses the various ways in which the country can ensure a bright and prosperous future for all its citizens.

SORT_OCN

This program sorts an OCNDATA file (in binary format) by station code. The output will also be in binary format. OCNDATA files must be ordered by station code in order to be submitted as input to other programs including MAKE_SUB, ADD_STN and RTRV_HMC. SORT_BOT changes the primary order of a file from cruises (with stations ordered by increasing station code for each cruise) to stations (with cruises ordered chronologically for each station). When new data are obtained from SIO to update the database, the stations are ordered in the same sequence as they were occupied during the cruise and each cruise is a separate file. Consequently, each cruise file must be sorted to get the desired order of stations and then ADD_STN can be used to combine the cruise files. In the current archive format for OCNDATA data (binary), all of the cruises conducted in a calendar year are stored in one file. Yearly files are small enough to be stored on 5.25 or 3.5 inch floppy disks and can easily be partitioned into cruise files with MAKE_SUB or PART_OCN.

An option is provided to include or exclude station header records in the sorted file. Header records must be excluded when creating sorted files for input to FIT_HMC. For most other applications the header records must be included. PRNT_OCN, for example, can display sorted OCNDATA files with or without header records.

PART_OCN

This program creates individual cruise files from OCNDATA files (in binary format) containing multiple cruises. The primary order of the OCNDATA file must be by cruise codes. This program is easier to use than MAKE_SUB, since it requires no parameters. It copies every cruise on the source file to a new file.

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TO
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PRESENT
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NEW-YORK
1856

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NEW-YORK
1856

Menu 2. UPDATING THE CALCOFI DATABASE

The physical and chemical data from CalCOFI cruises are processed by SIO and published in data reports. When the data are ready for publication, they can be obtained on magnetic tape, or other media, from SIO. At the present time the person to contact is Arnold Mantyla (Ph 534-2015). Under the current procedures, the SIO tape must be delivered to the UCSD Academic Computer Center (SDCC1) and copied to disk. The VAX command file COPYFRFTP will accomplish this. However it must first be edited to ensure that the name of the tape, the number of files on it and the block size are correctly entered. To determine the blocksize, multiply the logical record size (128 bytes) by the blocking factor. The latter is usually written on the tape label and, recently, has been either 10 or 15. Next, the data must be downloaded to a PC at SWFSC with Kermit, Procomm or another suitable communications program. If more than one file was copied from the tape to disk, be sure to rename them before downloading and give each one a unique filename extension. When the files are copied from tape to disk they are distinguished from each other only by version number. Since MS_DOS does not recognise version numbers, that distinction would disappear when the files are transferred to the PC and all but the last file transferred would be lost.

A more efficient procedure may soon be instituted. The CalCOFI data are processed on the SURF computer at SIO. Under a new arrangement, data from the last two cruises of 1991 were transferred directly from the SURF computer to a PC at SWFSC via the UCSD LAN.

The programs listed in Menu 2 (Figure 2), and described below, outline the sequence for processing the data from SIO. If the data are transferred by the UCSD LAN rather than by magnetic tape, the first program in Menu 2 (UNBLKDPG) will no longer be needed.

UNBLKDPG

This program unblocks the files of CalCOFI data received from SIO and downloaded to a PC at SWFSC. Logical record size in DPG files is 128 bytes. A physical record (block) on the tape files usually contains 10 or 15 logical records (1280 or 1920 bytes). The number of logical records per block (blocking factor) is usually written on the tape label. The program will ask for it at run time. If the blocking factor is more than 25, the constant <MaxBlkSize> in the program source code must be modified and the program re-compiled. The value of MaxBlkSize should be equal to:

$$(128 * \text{maximum_blocking_factor}) + 2.$$

The records in the unblocked files will have the same format as the logical records in blocked files.

DPG_PCD

This program extracts selected fields from the unblocked DPG files created with UNBLKDPG and copies them to files in the PCDATA format. The record length in this format is 90 bytes. Blank fields are reserved in header and data records for values to be

computed and inserted by program EDIT_PCD, in the next step. The PCDATA format is used to archive data from Nansen casts at observed depths or from CTD casts at digitized depths. It provides fields for nutrients and productivity data.

EDIT_PCD

This program completes the preparation of PCDATA files. It computes CalCOFI station codes for the header records, and density fields for the data records. It also performs range checking for many of the data fields and, when possible, inserts interpolated values in fields with missing data. PCDATA files are text files in ASCII format.

PROD_HDR

This program searches a PCDATA file for productivity stations. They are identified by the letters <PR> in columns 72-73 of the header records. The header records of productivity stations are copied into a new file. Header records include a field with integrated mean values of C14. The file of productivity header records is to be delivered to Dr. Paul Smith.

UPDATOCN

This program converts the PCDATA (ASCII) format to the OCNDATA (binary) format. It creates files with data interpolated to standard depths from 0 to 500 meters, from the observed depths in PCDATA files. It computes and adds fields for density (sigma-t), dynamic height anomaly and percent oxygen saturation.

SORT_OCN

This program was described with the programs in menu 1. It is listed again here because it represents the last step in the OCNDATA update process. Data recieved from SIO in DPG files are ordered by the time sequence in which the stations were occupied. SORT_OCN orders the data in each cruise file by increasing station codes. Data from each CalCOFI cruise are received from SIO in a separate file. The cruises are kept separated throughout the update process and SORT_OCN is run for one cruise at a time. Then when the sorted cruise data are combined to create yearly files or added to files that contain all or portions of the entire period of record, the primary order of the data by cruises will be maintained.

MAKE_PCD

This is a data entry program to create computer files in the PCDATA format from hardcopy or data on media not suitable for computer input. It accepts keyboard input, checks for valid entries and creates PCDATA files, with blank fields for parameters not entered. A program session can initiate creation of a new file or continue data entry into one initiated in a previous session. When a file is completed, it can be submitted as input to EDIT_PCD to complete the insertion of density parameters and to UPDATOCN to create a file in the OCNDATA format..

Menu 3. UTILITY PROGRAMS

GRID_CON

This program converts line and station coordinates of the CalCOFI grid to latitude and longitude, and vice versa. It runs in an interactive mode and prompts the user to enter coordinates from the keyboard. Results are displayed on the screen. Line and station numbers can be entered with or without decimal places. Latitude and longitude must be entered in degrees, minutes and tenths of minutes with no embedded spaces and no decimal point. Minutes and tenths must be entered as a three digit field; leading and trailing zeros may not be omitted. Keyboard entries must be separated by spaces.

MARK_OCN

This program interpolates depths for a specified value of a data parameter in an OCNDATA file, and creates a new file with records inserted for the interpolated depths. For example, if sigma-t were selected as the data parameter and 25.8 as the specified value, the depth at which sigma-t equaled 25.8 would be computed for each station in the file and inserted into the file as a new record. The new record would also contain values of temperature, salinity, oxygen and oxygen saturation interpolated to that depth. The value of dynamic height (ninth field of OCNDATA records) would be replaced by a marker code in the newly inserted record and by zero in all of the other records. MARK_OCN provides a special option to insert records to mark mixed layer depth. For this option, mixed layer depth can be defined either by temperature (the depth at which temperature is 1.1 C below that at the surface) or by density (the depth at which sigma-t is 0.3 g/L above that at the surface). Both input and output files will be in ASCII format.

The marked records in files created with this program can be identified and selected by program EDMAP for mapping data parameters on a surface that represents a constant value of some reference parameter. For example, temperature could be mapped on a surface where sigma-t equals 25.8.

NTRP_OCN

This program interpolates depths for values of a designated data parameter at specified intervals for a file in OCNDATA (ASCII) format. When the designated parameter is depth, a new file will be created for depths at the specified intervals with values of all data parameters interpolated to those depths. When any other data parameter is designated, the interpolations are performed in two steps. First, a list of depths are interpolated which correspond to values of the designated parameter at the specified intervals. Second, values of each of the other data parameters are interpolated for each depth in the list. A new file is created which contains only the interpolated data, the original records are not included. The program provides an option to replace percent oxygen saturation with stability as a new data parameter. Stability is computed as the rate of change of sigma-t with depth using 10 meter increments. Consequently, when this

option is selected, the designated data parameter must be depth and the increment for interpolation must be 10 meters.

PCD_INDEX

This program displays the header records of PCDATA files and, optionally, echos the output to a printer. It monitors the count field in each header record and, if the count of data records is incorrect, terminates the program and displays a message on the screen.

INVT_DYN

This program transforms values of dynamic height anomaly in OCNDATA (binary) files from the reference level at 0 meters (the default level) to a reference level at 500 meters. The results are saved in a new OCNDATA (binary) file. This transformation is necessary when dynamic height anomalies are to be mapped to depict geostrophic current at selected depths relative to that at 500 meters. The transformation is performed only for stations that extend to 500 meters. For others, values of dynamic height in the new file will be zero.

Menu 4. HARMONIC COEFFICIENTS

The seasonal variations of oceanographic parameters in the CalCOFI region approximate sinusoidal patterns, at least in the upper layers. The application of harmonic coefficients to describe the annual cycles of oceanographic parameters, and the computation of such coefficients by least squares regression, was described by R. J. Lynn, in CalCOFI Reports, Vol XI, 1967. The programs listed in this menu can be used to compute the annual and semiannual harmonics for six data parameters at CalCOFI stations for which sufficient data are available. The criteria for sufficiency, in this context, is defined as a minimum number of hydrographic casts in the data record for each of six 59 day periods, between January 1 and December 20. These dates essentially mark the CalCOFI year. This criteria precludes the occurrence of large data gaps in the annual cycle, which could lead to uncontrolled fluctuations in the seasonal cycles. The minimum number must be determined by the user and submitted at run time. The coefficients can be applied to compute seasonal means and anomalies for data parameters at standard depths at CalCOFI stations. The benefit of harmonic coefficients for describing seasonal variation is that they can be computed from data collected at irregular intervals and used to estimate mean seasonal conditions for any date in the annual cycle. Also they are economical with respect to storage space. A set of coefficients for each data parameter at each depth for each station consists of just five numbers.

Two files of harmonic coefficients are included with the RUNCCOFI program package, HMCOEF.ALL and HMSOCAL.ALL. The first of these represents the period 1950-1984 and includes all stations in the CalCOFI pattern that met a minimum data requirement of two casts per 59 day period. The second one represents the period 1950-1991 and contains all stations between lines 76.7 and 93.3, inclusive, that met a minimum data requirement of six casts per 59 day period. The latter set of coefficients applies to the portion of the CalCOFI pattern that has been occupied since 1985, and was computed with more stringent minimum data requirements to provide more reliable values of seasonal means and anomalies. This file contains coefficients for 54 stations. The programs in Menu 4 are described below.

RTRV_HMC

This program uses the binary file of harmonic coefficients created by FIT_HMC to compute means or anomalies or standard deviations of data parameters at CalCOFI stations. It can also copy the coefficients to a text file. The options are MEAN, CYCL, ANOM, SDEV AND COEF. Means are computed for a list of dates (designated by numbers from 1 to 365) and a list of stations submitted by the user at run time. The station list can be submitted from the keyboard or from a disk file. CYCL also results in means computed for a station list, but for dates at a fixed interval rather than a list of specific dates. The user submits the number of dates to compute means for and that number determines the interval. ANOM and SDEV result in computations of anomalies and standard deviations, and require input of actual data from an OCNDATA file sorted by station code. The sorted file must have been created by program SORT_OCN with the header option set to include station header records. The computations are performed for every station in the OCNDATA file, that is also represented in the harmonic coefficients file. Anomalies are computed as differences between the actual data values,

recorded on a particular date, and the corresponding values obtained from harmonic coefficients for that date. Standard deviations are computed from the sums of squares of the anomalies. The option COEF was provided to create a text file of the harmonic coefficients along with counts and standard deviations of the data parameters they were computed from. Consequently, the sorted OCNDATA file submitted with this option should represent the same data that was used by FIT_HMC to create the harmonic coefficients file.

PRNT_HMC

This program creates a text file containing tables of harmonic coefficients for six data parameters at selected stations. The coefficients are listed under the column headings: A1, B1, A2, B2 and C. The value of a parameter, P, for a particular day in the year can be computed with the formula:

$$P = A1 * \cos(R) + B1 * \sin(R) + A2 * \cos(2 * R) + B2 * \sin(2 * R) + C$$

where $R = 360 * \text{DAY} / 365$, and DAY is in the day of the year (range 1..365) for which P will be computed. For each station selected, tables will be printed for all six parameters: temperature, salinity, oxygen, sigma-t, percent oxygen saturation and dynamic height anomaly.

HMC_INDXX

This program displays header records from a file of harmonic coefficients. In addition to station code, period of record, latitude and longitude, it lists the number of times each station was occupied in each of the six 59 day periods in the annual cycle. An option is provided to echo the output to the printer.

FIT_HMC

This program computes harmonic coefficients from CalCOFI data in OCNDATA files in binary format. The input file must be a file created by SORT_OCN with the header option set to not include header records. FIT_HMC will compute coefficients for all stations on the input file that meet the minimum data requirement, as explained earlier. That is, a station must have been occupied a specified minimum number of times in each of six 59 day periods between Jan 1 and Dec 20. The minimum number is submitted as a program parameter at run time. The file created by FIT_HMC will be a binary file. It can be accessed by RTRV_HMC for computing means and anomalies, and by PRNT_HMC and HMC_INDXX for displaying its contents.

